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SCIENCE

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THE VALUE AND SERVICE OF ZOOLOGICAL SCIENCE¹

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SPIRITUAL VALUES

THE material values of science are often heralded, while its spiritual values pass unnoticed. Leaving all tangible values unemphasized, we shall here contend that the intangible values of science in general and of zoology in particular are the more significant. These we may characterize as "spiritual," using the term over against "material" and without further implication. Thus, if we speak of man's spiritual yearnings in contrast with his material needs, we may not have a clear idea of what this phrase implies, but we recognize in this contrast the existence of something the opposite of material. That which constitutes "the spirit of the man" is too illusive for definition, yet it is a thing we recognize as existent and in such a sense the word spiritual is used.

In the present world crisis there are none who decry the material values of science. Our very national existence depends upon them. But there are many who raise the question whether science on its spiritual side is not a failure, whether the war is not science gone mad; and we scientists need to consider what is the source of this undercurrent of criticism which sets against the freedom of science. In the eyes of the man in the street, science represents only material accomplishment and even among the educated such a belief is not uncommon. We men of science do not believe this. Why should others? Perhaps we are to blame

¹ Symposium before the American Society of Zoologists, Minneapolis, December 29, 1917.

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for not having taken the public sufficiently into our confidence. If it is our belief that science has emancipated the spirit of man by freeing it from ignorance and superstition, and in so doing has brought advantages in excess of the material comforts which are the more obvious fruits of scientific progress, it is time we laid more emphasis upon these intangible values. For by these we live and work, rather than by the desires of a sordid materialism.

1. MATERIAL COMFORT AND SPIRITUAL PROGRESS

Betterment of his material surroundings reaches beyond man's physical comfort; for such betterment enables him to fix his attention upon "that which is not bread." We reach the heights now and then from the flood of difficulties which surrounds us; and there may be all the more satisfaction in this, when we do so in spite of adverse conditions, when we will not be wholly fettered by mere circumstance. Yet for sustained achievement in nation or individual there must be relief from an oppressive struggle for existence. What H. G. Wells² has termed "this misery of boots" must be overcome before we can realize our spiritual desires. Those who have lived as the favored members of society may prate of their superiority over material things; but one suspects that a sojourn in a New York tenement or a Pittsburgh slum would convince any one of us that he owes much of what he has accomplished to the stability of his material foundations, and to the absence of acute pressure in matters of food and shelter. Some of us call ourselves poor, comparatively speaking; but we have frequent relief from toil and much of our toil has al-

² Wells, H. G., "This Misery of Boots," Ball Publishing Co., Boston, 1908.

ways been self-imposed. On the other hand, conditions that are too easy are not conducive to spiritual progress; for we are not yet far enough removed from the state of nature, under which we took origin, to react favorably in the absence of stimulation. The proposal to fill men's stomachs as a stimulus to their morals is worth considering, even though history and experience show that the hardest thing for man or nation to thrive upon is material prosperity. A fair degree of prosperity is indispensable, though excess may prove disastrous.

Now one of the things science has done is to establish our prosperity. In civilized lands, we can be sure of enough for the entire population to eat and of enough to wear. The problem is no longer how to produce the necessities of life so much as how to distribute them. In matters of production we are far ahead of our power to effect a just distribution. The socialists are right in their contention, that if we would deal fairly in distribution no man would be obliged to work more than four or five hours a day and that each could devote the remaining time to his spiritual interests, that under such a system many of our social problems would disappear. Our first claim for science, as having spiritual value, is, therefore, its establishment of the material foundations upon which spiritual advancement rests. While this value should not be minimized, since it lies at the basis of civilized life, it is easy to cite other values not so immediately allied to things material.

2. SCIENCE AND IMAGINATION

We often hear it said that, since science has destroyed the mystery of the universe, nothing remains for imagination. This statement has, I think, no basis in fact, and

arises from the failure to appreciate what science has done. Instead of restricting our imagination science has so enlarged our horizon that we may take a bolder flight. To the mind of primitive man and to the savage who survives in this state until our own times, nature appeared a thing of caprice rather than of order. The world was one of spirits, good or evil, who must always be considered, with whom man must make his peace. The day as well as the night was peopled with beings who ruled in the absence of any definite sequence of events and safety could be found only by submission to their caprice or propitiation of it. Under these conditions imagination had full play. But who in our generation would choose this brand of imagination? When man first observed the changeless motion of the stars "without haste, without rest," and gained an inkling that the same orderly sequence might apply to all natural phenomena, the opportunity for imagination was not lost. It was placed on a higher plane. The inhabitants of Europe, who once imagined Hell or the "Islands of the Blest" to lie beyond the Atlantic, have lost many fields in which the imagination of medieval man found exercise; but what a vista has been opened. Consider the sweep of the evolutionary conception through time and space. Or consider man as the victor over nature, notwithstanding those laws which are inexorable for other living things. No other species is known to have spread itself so widely over the earth and to have so changed its environment to suit its needs. Herein lies the difference between man and the rest of the animal world. Wherever else an animal has been subjected to a new environment, the result has been death or the evolution of a new type suited to meet the changed conditions. But man has taken himself and his domesticated plants

and animals into surroundings to which neither he nor they are properly adapted; and instead of paying the penalty inevitable in a state of nature, has survived and the creatures under his care have survived with him. Where nature would say "Die!" man has said, "I will live!"; and he has succeeded in this because he forces from his environment the readjustments necessary for his well-being. Not always is this possible. The path is not trod with ease, but it is being steadily pursued. In his essay entitled "Nature's Insurgent Son," Lankester³ thus compares man to an insurgent gone so far in his rebellion that there is no return; for capitulation can mean only death. The rebel must continue on his course until the end is won, if he is to find safety. He can not now return to the dominion of nature, he must succeed by controlling his surroundings, and knowledge of how to do this is more vital to him than aught else.

Again, take the poetry in modern invention. For it is there in plenty when you know how to find it, as Kipling has done time and again, but nowhere better than in his verses on "The Deep-sea Cables."

The wrecks dissolve above us; their dust drops
down from afar—

Down to the dark, to the utter dark, where the
blind white sea-snakes are.

There is no sound, no echo of sound, in the deserts
of the deep,

Or the great gray level plains of ooze where the
shell-burred cables creep.

Here in the womb of the world—here on the tie-
ribs of earth

Words, and the words of men, flicker and flutter
and beat—

Warning, sorrow and gain, salutation and mirth—
For a Power troubles the Still that has neither
voice nor feet.

They have awakened the timeless Things; they have
killed their father Time;

³ Lankester, E. R., "The Kingdom of Man,"
Holt and Co., 1907.

Joining hands in the gloom, a league from the last of the sun.
Hush! Men talk to-day o'er the waste of the ultimate slime,
And a new Word runs between: whispering,
"Let us be one!"

Is there not food for imagination in the phenomenon of the wireless message? A few years ago I spent a summer at the Puget Sound Marine Station. On a hill behind us was a wireless establishment to which we sometimes tramped for a chat with the operators. One day we were told with pride they had just picked up a communication from Key West, the longest distance from which that station had ever received a message. We below the hill had known nothing of this. "Warning, sorrow and gain, salutation and mirth" had passed over our heads on the wings of the air, and the telling of their passage was a revelation of things in the universe of which man knoweth naught, but which are not unknowable. To my mind we have gained more with the advance of science than we have lost; and imagination need not go unfed, when out of the fog, the night and the distance, as though from another world, comes that which signals "Save our Ship," to listening ears a thousand miles away on sea and shore.

3. SCIENCE AND ESTHETIC APPRECIATION

Esthetic appreciation may seem as distant from science as are the poles from one another. Yet if we analyze the case, our esthetic response becomes, when stripped of what is non-essential, an intellectual rather than a sensual pleasure. The "good, the beautiful and the true," as we see it, is largely that to which we are accustomed, whether it be a brand of perfume, a style in skirts or a scientific theory. Also its cost, as Professor Veblin⁴ shows, is an in-

⁴ Veblin, T., "The Theory of the Leisure Class," Macmillan Co., 1912.

fluent factor. Personally, I hold to the faith that there are such things as the beautiful and the ugly, that it is not all a matter of that to which one is accustomed, only I often doubt whether any of us know what's what. Within the purely intellectual realm, however, we are on safer since more common ground. For example, the satisfaction one has in the demonstrated theorem or in the chain of evidence when the last link is forged, is an esthetic satisfaction. There is the same feeling of completeness as in beholding the creation of artist or sculptor from which nothing could be taken away or nothing added without marring its perfection. Say that we appreciate such things merely because our minds run in certain channels. The fact remains that our minds so run, and that as long as human minds continue to be what they are we may expect them to follow similar courses. Stories are told of great minds completing their scientific discoveries in a state bordering on religious exaltation, but many of us have felt the same thrill even though the work were not our own. The writer remembers how when a student he was taken by the "Mosquitomalaria Theory," as it was then called; and at a later date the esthetic appreciation with which he contemplated the apparent explanation of Mendelian segregation and of the determination of sex in terms of the behavior of chromosomes. In spite of uncertainties and the need for further investigation, one felt himself gazing at a picture near enough completion to show what it might become—a sequence so wonderfully ordered as to call forth an esthetic fervor. To many of us, therefore, scientific thinking and the contemplation of the theories of science present an esthetic appeal of the first order.

4. SCIENCE AND FAIR JUDGMENT

A further aspect of science, having spiritual value, is the habit of fairmindedness induced by scientific reasoning. If scientific thinking is but a way of looking at things, the essential element of which is the formation of impersonal judgments—the reasoning in a way to reduce the personal equation to a minimum; if in this respect alone does the knowledge of science differ from that of everyday life, science may perform an important service by helping us to impersonal judgments in other lines.

To illustrate concretely, a teacher of theological students, desirous of imparting information regarding the origin of man, might find an effective approach through geology. There is little to arouse prejudice in the study of weathering, erosion, deposition and glaciation. When, however, these lessons have been learned, with their inevitable inference regarding the lapse of time, one finds an easy passage to the problems of organic evolution and thence to the question of man's origin. The same methods of reasoning are used throughout; only, in the last case, there is much to excite prejudice and this prejudice might be aroused by attacking the problem of man without preliminaries. So great is the similarity in the scientific method, wherever used, that the viewpoint obtained in an impersonal subject like geography, astronomy, or geology can be taken over bodily to allied fields. And the interpretation of phenomena remote from personal interest induces a dispassionateness which is a good point of departure for a journey into debatable territory.

The whole theory of evolution may be cited in further illustration. If this be presented as an interpretation of the facts of nature, to be accepted or rejected on the same basis as one would the earth's spheric-

ity or the Copernican theory of the solar system, it is easy to show that the cases are parallel, when viewed impersonally and as scientific problems. Once into the subject, one passes insensibly to the problems of society, which are at bottom evolutionary problems. Poverty and crime, eugenics and euthenics, the organization of the state, and the rights of the individual are debatable in no such simple terms as comparative anatomy and embryology, paleontology or ecology; and because of this are subjects for prejudiced controversy rather than open-minded discussion. Take the case of poverty. How can a man with the scientific temper regard this as a question to be decided wholly in terms of the convenience or profit of landlord or employer of labor? The biologist might be influenced by his preconceptions of heredity and environment, but in so far as he shut his eyes to the evidence and failed to consider all the factors involved, he would be false to his scientific spirit.

Human beings suffer much from emotionalism in public matters. We shall doubtless continue to be guided by our hearts rather than our heads, but it is to be hoped we may come to use better judgment. In public affairs, it is particularly important that we think things out. At the beginning of all clear thinking in these matters are the facts of science, and the method of science is needed at every turn. If the question is upon religious revivals of the old-fashioned sort, we need to know, with such degree of scientific accuracy as is possible, the history of these movements in the past, and their psychological aspects in the present, before we can determine relative values. Now that democracy is spreading, we need, as never before, to correlate facts and weigh evidence in the dispassionate manner which is the ideal of

science. It is of little value to love truth and justice, if our ignorance makes it impossible for us to understand what is truth or how to do justice in a given instance. Truth may be relative and justice approximate, but we could do a far better job of it by making intelligent use of the facts we have.

Many of us believe that science has done more to help the cause of truth and justice in society than has any other line of human endeavor; for science has taught man the sequence of events to which he must conform if the individual or the nation is to reach its highest development. Because of scientific teaching, men demand to-day reasons for conduct other than traditional prohibitions or indulgences. And these reasons must be based upon scientific facts and presented in terms of scientific method. Science furnishes the groundwork to which our ethical judgment must conform. The old, emotional forms of thought play a losing game. Sentimentality is losing its grip in favor of a calm, farsighted determination to know what is true that we may do what is right, which is the highest ethical ideal. Science does not furnish the incentive to truth and justice, but it does furnish the material out of which truth and justice may be constructed by use of the scientific method; and for the individual, it furnishes the data needed for a well-ordered life.

If you can keep your head when all about you
Are losing theirs and blaming it on you;
If you can trust yourself when all men doubt you,
But make allowance for their doubting too:

Here again, Kipling states our case; for he presents the ideal of striving for truth and justice, not blindly but with a view to the whole situation.

We contend that the scientific method furnishes the only safe approach in our attack upon the complex problems of human

life; since it enables us to approach these problems in a saner fashion, making for dispassionate judgment and for the elimination of prejudice. Now this elimination of what influences the "you" and the "me," in favor of what can be agreed upon as a fair interpretation by us all, is no easy matter. Scientific men do not always live up to their ideals within their own domain nor do they always carry over their ideals to daily life. But this impersonal way of thinking is a priceless possession, and if scientific men strive to apply it in life generally the effort is worth while however short it falls. We need more facts of science for our material progress, but more than this we need the method of science for the penetration of sham and for the elimination of personal interest in our dealings. The plea is not that the scientist is always a good citizen, but that the scientific method is useful for the citizen; that, as social life becomes more complex, it is necessary for the citizen to apply this method as a tool wherewith to shape the conclusions which shall guide his conduct.

5. SCIENCE AND EMANCIPATION

Finally, the value of science inclusive of every other is its influence upon our mental outlook; for only by the acquisition of a scientific habit of mind do we find intellectual emancipation. In substantiation of such a claim, we may cite the theory of organic evolution, which is the most comprehensive illustration afforded by the biological sciences, and perhaps by science generally.

The evolutionary concepts current among the Greeks were tinted with philosophy. Lacking concreteness, they made little headway; and we find the beginnings of modern evolutionary doctrine in the accumulation of facts regarding animals and

plants which marked the centuries just preceding the year 1750. To Buffon and to other less known writers of the eighteenth century belongs the credit for having first promulgated the evolutionary theory in a form which was scientific rather than philosophical and which carried a measure of conviction, despite its crudities and the hampering of theological criticism. One can not turn the pages of Buffon's encyclopedic work without a growing respect for the knowledge of animal life there represented. Obviously, the foundation for much of our comparative anatomy of vertebrates was even then established. It is a familiar story how Lamarck was the first to offer a theory of the causes of evolution; how he failed to make his case as against the authority of Cuvier; how the latter, although opposing evolution, accumulated some of our strongest evidence, through his studies in comparative anatomy; and how von Baer supplemented this by his work in embryology; until in Darwin's day there were ample facts at hand for the establishment of the fact of evolution, if not for the determination of its causation.

As Professor Lovejoy⁵ has pointed out, evolution itself aside from its causes might have been accepted, as the only reasonable interpretation of the facts, at any time after the year 1840. That it was not so accepted among those who ridiculed the "Vestiges of Creation," is a sad comment upon the open-mindedness of science and the psychology of conviction in its relation to evidence. The story that science hesitated for lack of evidence, only adduced by the "Origin of Species," does not represent the facts. Though we have inher-

ited this tradition from so clear a thinker as Huxley, we should be anxious to replace it with a frank avowal, that the two decades following 1840 present a humiliating spectacle to workers who pride themselves upon the acceptance of doctrines whenever and wherever the evidence is forthcoming. The fact is that during the period in question science may well be accused of shutting its eyes to patent evidence. Darwin's claim to distinction lies in his early recognition of the evolutionary problem as at the core of biological science, and in his marshalling of facts for evolution and for his theory of "Natural Selection" in a manner that was overwhelming. The almost immediate acceptance, in biological science, of Darwin's views and the spread of the evolutionary concept to other fields during the remaining years of the nineteenth century are well known. Evolution has won its fight. We are here concerned with its effects upon human thinking in the past and its probable influences in the future.

The triumph of the evolutionary conception completed the overthrow of those older ideas of the universe which culminated in medieval theology. Evolution was the final extension of that enlarging horizon disclosed by the theory of the earth's sphericity and the Copernican theory of the solar system, concepts which are indissolubly united and which represent each a stride forward in the face of diminishing resistance. It went hard with Galileo, and so would it have gone with Copernicus had all the implications of his theory been recognized before his death. Buffon was not in physical danger, though forced to recant. Darwin, though heaped with abuse, suffered not even inconvenience at the hands of his critics. During the three centuries involved, man's picture of himself

⁵ Lovejoy, A. O., "The Argument for Organic Evolution before 'The Origin of Species,'" *Popular Science Monthly*, November and December, 1909.

changed from that of a being, recently created and awaiting a day of judgment in the not distant future, to that of a being originating as part of organic nature and set in a universe without beginning and without end. The by-product of this intellectual revolution was an emancipation of the human spirit from the bonds of authority. Authority indeed remained, but no longer that of book or pope. In its place came the authority of nature; and so great was the change we have not yet recognized its full significance.

While we can the better visualize the effects of evolutionary doctrine by thus going back several centuries, it is equally important to recognize what is happening to-day, how this doctrine has affected theological belief since the year 1859, what has happened in philosophy, and what changes have occurred in our outlook upon the problems of society.

In theology, the evolutionary doctrine is carrying us from the concept of a single religion, revealed to man by agents duly inspired, to a multitude of religions of varying worthiness, but all the outgrowth of yearnings which originated with human intelligence. We need not condone the shortcomings of the fathers nor strive for theological explanations of sin and death, of sorrow and pain since these are the not unnatural incidents of our evolution. We know in part whence we came, if not whither we are going, and it is enough if we may by our own efforts somewhat improve the material and spiritual state of ourselves and our children. This new viewpoint has been reached not by a sudden break with the past, but by a gradual shift of mental attitude which makes the older doctrines impossible of acceptance. We have applied the evolutionary concept to religion, as to every other expression of

organic nature; and the result has been a revolution, accomplished before its beginnings were recognized. Thus science has brought emancipation from theological bondage and set free the spirit of man for higher flights in the future.

In philosophy, the evolutionary theory has necessitated the change from a static to a dynamic universe, as witness the contrast between the philosophical systems of the early nineteenth century and the views of Bergson. This change has not yet completed its remodeling of philosophical theories, but only a philosopher can explain its workings.

In the field of social phenomena, we see the influence of the evolutionary theory through the recurrent questioning of the necessity for existing conditions. If the revolutions of the eighteenth century attacked the foundations of civic power and sought to install the authority of peoples over that of kings, the revolution induced by the evolutionary theory has shaken the whole edifice of social tradition. Whatever *is* may be the natural outcome of the evolution of society to date, but it is not thereby right nor is it necessarily permanent. We may, as evolutionists, recognize the stability of social customs, which have arisen by evolution; but we also recognize these customs as subject to change. Moreover, we must consider the intelligent direction of our future evolution as a possibility, however remote. Evolution has not always taken the most desirable course, as witness the degeneration incident to parasitism; and while we shall probably have little to do with its outcome in the human species, what we may do is worth considering. Germany has evolved a social organization threatening the ideals which dominate the majority of western nations, in challenging which we are striving to direct

the course of social evolution. If we succeed, individualism working collectively will triumph over medieval collectivism.

The influence of the evolutionary conception may be seen again in our attitude toward social problems such as disease and crime. These are not inevitable conditions to be treated by curative measures only. They are to be attacked with all the knowledge of hereditary and environmental factors we can command, and finally eliminated by the evolution of a type of man and a form of society in which such excrescences will be non-existent. We are no longer content with our lot, merely because things have been as they are within the memory of man or because we see no prospect of immediate change. Things have changed in the past and we want to change them in the future. We are not content to let evolution take its course with us, we want to make it go our way. Thus the insight into social changes which evolution brought has given a habit of mind that will brook no restriction upon the human spirit. As with philosophy, we have the change incident to an outlook upon a dynamic as opposed to a static world.

In conclusion, we have shown that science feeds the spiritual as well as the material man. Science deals with what we can measure and weigh, is wholly impersonal, is a thing of the intellect rather than of the emotions. But the intellect and the emotions are not separate entities of the mind, rather the mind is a unit which has its intellectual and its emotional sides. The raw material of scientific fact is susceptible of unlimited organization within the mind and this process of organization gives play to our spiritual nature. If we have made our point, the progress of science has given the spirit of man far more than it has taken away.

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MEASURES FOR PROTECTING WHEAT-FLOUR SUBSTITUTES FROM INSECTS

READERS of SCIENCE may be interested in work being done to prevent the loss of wheat-flour substitutes due to insect attack. Many of the millers and dealers who handle the cereals which the Food Administration is now requiring as substitutes for wheat flour have always recognized them as being subject to insect attack to such a degree that it has been considered poor policy to handle them extensively during the summer months.

The amount of embryo which is included in a flour, and the coarseness of the product are usually taken as an index of susceptibility to insect attack, coarse flours with the most embryo being the most susceptible. The wheat-flour substitutes and other cereals contain embryo, are relatively coarse, and are known to be highly susceptible to insect attack.

Millers, dealers and consumers, will handle more of the susceptible cereals than usual this summer and, unless unusual care is taken to protect them, the requirement of the Food Administration may result in an increased loss of food and thus defeat the object of the government. However, such losses can be prevented and, if proper precautions are taken, the handling of wheat-flour substitutes need not lead to serious complications with insect pests. The division of entomology and economic zoology in cooperation with the department of animal biology at the University of Minnesota, and the Minnesota State Food Administration have been outlining recommendations and methods for aiding the millers, dealers and consumers of Minnesota in preventing losses of wheat-flour substitutes. The measures are preventive and it is proposed to cover the state with propaganda before any serious trouble has arisen.

The millers are probably the best prepared for the new conditions. The operators of the large flour mills in Minneapolis have learned from experience that these cereals must be carefully handled and they were the first to anticipate complications arising from the wartime emergency. The cereals which are put upon the market in sacks are not permitted to remain in storage but are hastened to the con-